10 GEOLOGY, MINERALS, SOILS, AND PALEONTOLOGICAL RESOURCES

This chapter identifies and evaluates the changes in conditions related to geology, including seismic conditions, minerals, soils, and paleontological resources associated with implementation of the proposed project. The analysis addresses potentially significant geology and soils effects and impacts to paleontological resources, and mitigation measures recommended to reduce significant or potentially significant environmental impacts to less-than-significant levels.

The examination of geology, minerals, soils, and seismic issues is based on information from:

- site observations;
- review of existing and available information published by state and federal agencies regarding the geology, minerals, soils, and seismicity of the area;
- a draft mine reclamation plan and addendum completed for the proposed project by Carlton Engineering, Inc. (2003, 2004); and
- a geotechnical report completed for the proposed project by Raney Geotechnical (1998).

10.1 EXISTING CONDITIONS

REGIONAL GEOLOGY

The project site is located within the alluvial valley of the Bear River. The geographic setting is the eastern margin of the northern portion of the Great Valley Geomorphic Province of California. The mountainous terrain of the Sierra Nevada lies directly to the east. The Great Valley consists of the Sacramento Valley, which extends northward from the Sacramento–San Joaquin Delta to the southern end of the Cascade Range, and the San Joaquin Valley, which extends southward to the Sierra Madre Mountains. The Sacramento River flows southward through the Sacramento Valley with numerous tributaries draining the Coast Ranges to the west and the Sierra Nevada to the east.

The project site is bisected by the Bear River, one of numerous major rivers draining the Sierra Nevada mountains. The Bear River is tributary to the Feather River; the confluence of the two rivers is located approximately 14.5 miles west of the project site. The headwaters of the Bear River are located in the mountains at an elevation of approximately 6,000 feet above the National Geodetic Vertical Datum (NGVD) of 1929. This river flows through mountainous terrain underlain by igneous and metamorphic rocks of the Sierran Batholith, and Cenozoic-aged sedimentary and volcanic rocks. Erosion of the mountains provides the river's sediment load.

The Bear River drainage basin was the site of extensive historic placer gold mining. During the period 1849–1949, approximately 255 million cubic yards of gold-bearing material were mined by the hydraulic method and transported into the Bear River (Hagwood 1981). Large volumes of these sediments washed through the upper part of the watershed and were deposited primarily in the lower reaches of the river within the Sacramento Valley. The catastrophic sediment loads filled (aggraded) the channel and adjacent areas with up to 20 feet of sand and gravel deposits. The channel aggradation resulted in significant loss of flood capacity and increased flooding hazards within the lower reaches of the river. The sediments were deposited on the Riverbank Formation (Exhibit 10-1).

Quaternary alluvium deposits are estimated to be approximately 130,000–450,000 years old. The Riverbank Formation, which is exposed in the banks and bed of the Bear River, is a consolidated mixture of sands, gravels, silt, and clay. Although these deposits are, in general, relatively resistant to erosion, the lithologic variability of this formation results in variable susceptibility to erosion (WET 1991).

Longitudinal profiles of the Bear River channel surveyed in 1940 and 1990 indicate that up to 10 feet of incision (i.e., downcutting) occurred in the lower reach of the river over this 50-year period, an average of 0.2 foot per year (WET 1991). Although most of the erosive power of the river resulted in downcutting of the channel, lateral (i.e., sideways) migration of the channel (bank erosion) has also occurred. When the incising channel encountered the function between the highly erosive mining-derived sediments and the more resistant Riverbank Formation, lateral erosion of the banks formed in less resistant mining debris would likely occur. This phenomenon is evident in the lower subreaches of the river where a bench, or strath terrace, has formed along the top of the Riverbank Formation. Lateral erosion of the banks provides most of the sediment load for the existing channel.

In addition to channel incision, changes in the planiform (i.e., map view) of the pre-mining and pre-dam Bear River channel have occurred in response to alterations in channel hydraulics and sediment transport. The position of the channel has shifted southward to the middle of the alluvial valley in the area of the project site. In addition, the sinuosity of the channel (i.e., extent of curving) has been reduced throughout most of the lower reach of the river relative to pre-mining conditions (i.e., river is straighter than it was historically).

In the late 1980s, a detailed analysis of the changes in the channel morphology of the lower Bear River was performed (James 1991). Before the deposition of the mining-derived sediments, the channel of the Bear River was located along the northern margin of the river's active floodplain. In 1854, the position of the river defined the boundary between Placer and Yuba County. Therefore, the current county line marks the approximate position of the river at that time. Subtle topographic evidence (i.e., a partially filled linear depression) of the former channel is observable at the project site.

Cessation of hydraulic mining in the 1880s effectively cut off the artificially high sediment transport rates to the lower reach of the river. Deprived of sediment load, the "hungry" water increased the potential for erosion of the highly erodible mining-derived sediments that formed the river's banks and bed. As a result, the channel began to incise. By 1931, the channel near Wheatland had downcut (approximately 14 feet) through these sediments, exposing the underlying Riverbank

Exhibit 10-1

Formation. In 1928, Camp Far West and Combie dams were constructed across the Bear River upstream of the lower alluvial reach, inadvertently leading to a further reduction in the transport of sediment and further promoting channel incision in the lower basin. However, during the period from 1931 to 1955, the channel bed elevation at Wheatland remained relatively stable; incision was limited to approximately 1–2 feet. The vertical incision was apparently limited by the resistance to erosion of a cemented, pebbly clay layer within the Quaternary alluvium. During a moderate flooding event in 1955, the resistant layer was fully penetrated.

Following this event, incision rates increased. During the period 1955–1970, the channel incised an additional 6–7 feet through less resistant stratigraphic units. During the period from the late 1970s through the 1980s, the bed elevation was variable, apparently responding to scour during flooding events and deposition during low-flow conditions (James 1991).

PROJECT SITE GEOLOGY

The project site is located on an alluvial plain formed in the valley of the lower reach of the Bear River. The surface of the alluvial plain is at an approximate elevation of 110–125 feet above NGVD in the central portion of the project site; existing mining operations have resulted in excavation of pits to 25 feet or more below this surface, and construction of stockpiles of excavated materials has created an uneven topography on the relatively flat original ground surface. The alluvial plain surface slopes gently to the west, the direction of flow of the river, and is terminated just to the east of the project site. At the project site, the plain is approximately 5,000 feet wide and bounded to the north and south by low rolling hills developed in older alluvial deposits, including the Riverbank and Laguna Formations (Exhibit 10-1). The Riverbank Formation is also exposed in the bed and portions of the bank of the Bear River, which flows through the project site. The height of the riverbanks ranges from approximately 6 feet to more than 20 feet. The lower bank heights are associated with the area of a wider active floodplain that has developed on the north side of the river, immediately upstream and downstream of the onsite bridge.

As described in the discussion of regional geology, the youngest deposits within the alluvial valley of the Bear River are Holocene alluvial sediments, including sand and gravel derived from hydraulic mining. Within the active and proposed mining areas on the north side of the river, the Holocene sediments overlie the Riverbank Formation. Subsurface investigations conducted at the project site indicate that the uppermost stratigraphic unit in the area proposed for mining is composed of sediments derived from hydraulic mining (Raney Geotechnical 1998). This deposit is 7–18 feet thick and consists primarily of fine poorly graded (i.e., well sorted) tan to white, fine sand and silty, fine sand with some coarse gravel. The bottom of this stratum was encountered at elevations between 98 and 106 feet NGVD. The sediments are young, unconsolidated, and have little or no cohesion; therefore, the erosion potential is high.

The mining-derived deposits overlie gray-brown and yellow-brown sandy, clayey, fine- to coarse-grained gravels. The gravel deposits are interrupted by silty, sandy clay deposits. Although the clay deposits are up to 6 feet thick in some areas, the layers appear to be discontinuous (i.e., not laterally continuous across the site). The interbedded gravels, clayey gravels, and silty clays extend to depths of at least 60 feet below ground surface. The deepest boring at the site (drilled within an active mining area) encountered a medium dense and slightly cemented silty sand at approximate elevation 54 feet NGVD that extended to the bottom of the boring (elevation 22 feet NGVD). These lower gravelly deposits are probably sediments within the Riverbank Formation. In the processing area, south of the river, the mining-derived sediments are not present and the uppermost stratigraphic unit is a yellow brown and red-brown silty, sandy clay with intermittent sand and gravel layers (GHHEI 1991). A generalized cross section of the near-surface geology at the project site is presented in Exhibit 10-2.

PALEONTOLOGY

Paleontological Resource Inventory Methods

A stratigraphic inventory and paleontological resource inventory were completed to develop a baseline paleontological resource inventory of the project site and surrounding area by rock unit, and to assess the potential paleontological productivity of each rock unit. Research methods included a review of published and unpublished literature and a search for recorded fossil sites at the UC Berkeley Museum of Paleontology. These tasks complied with Society of Vertebrate Paleontology (1995) guidelines.

Stratigraphic Inventory

Geologic maps and reports covering the geology of the project site and surrounding study area were reviewed to determine the exposed rock units and to delineate their respective aerial distributions in the project study area.

Paleontological Resource Inventory

Published and unpublished geological and paleontological literature were reviewed to document the number and locations and previously recorded fossil sites from rock units exposed in and near the proposed project site and surrounding study area, as well as the types of fossil remains each rock unit has produced. The literature review was supplemented by an archival search conducted at the University of California Museum of Paleontology in Berkeley, California on April 13, 2004.

Paleontological Resource Assessment Criteria

The potential paleontological importance of the proposed project site can be assessed by identifying the paleontological importance of exposed rock units within the project area. Since the aerial distribution of a rock unit can be easily delineated on a topographic map, this method is conducive to delineating parts of the project site that are of higher and lower sensitivity for paleontological resources and to delineating parts of the project that may therefore require monitoring during construction.

A paleontologically important rock unit is one that: 1) has a high potential paleontological productivity rating, and 2) is known to have produced unique, scientifically important fossils. The potential paleontological productivity rating of a rock unit exposed at the project site refers to the

Exhibit 10-2

abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near the project site. Exposures of a specific rock unit at the project site are most likely to yield fossil remains representing particular species in quantities or densities similar to those previously recorded from the unit in and near the project site.

An individual vertebrate fossil specimen may be considered unique or significant if it is: 1) identifiable, 2) complete, 3) well preserved, 4) age diagnostic, 5) useful in paleoenvironmental reconstruction, 6) a type specimen, 7) a member of a rare species, 8) a species that is part of a diverse assemblage, or 9) a skeletal element different from, or a specimen more complete than, those now available for its species. For example, identifiable vertebrate marine and terrestrial fossils are generally considered scientifically important because they are relatively rare. The value or importance of different fossil groups varies, depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they have already been identified and documented, and the ability to recover similar materials under more controlled conditions such as part of a research project. Marine invertebrates are generally common, well developed, and well documented. They would generally not be considered a unique paleontological resource.

The following tasks were completed to establish the paleontological importance of each rock unit exposed at or near the project site:

- The potential paleontological productivity of each rock unit was assessed, based on the density of fossil remains previously documented within the rock unit.

- The potential for a rock unit exposed at the project site to contain a unique paleontological resource was considered.

Paleontologic Resource Inventory Results

Stratigraphic Inventory

As discussed above in the Project Site Geology section, geologic mapping at a scale of 1:250,000 (Wagner et al. 1987), 1:62,500 (Helley and Harwood 1985) and 1:24,000 (Helley 1979) indicates that the Patterson Sand and Gravel mine is located on Holocene-age alluvium. More specifically, sand and gravel derived from hydraulic mining cover the project site north of the Bear River in deposits ranging from 7 to 18 feet thick (Raney Geotechnical 1998). Pleistocene-age alluvial gravel, sand and clay underlie the mining deposits, and sediments of the Riverbank Formation were encountered approximately 60 feet below ground surface. Sediments underlying the processing site, south of the Bear River, are similar to those north of the river except that the hydraulic mining debris are absent.

A small portion of the remaining project site, on both sides immediately adjacent to the Bear River, is composed of active Riverwash – recent sand and gravel deposited by the river.

Paleontological Resource Inventory and Assessment by Rock Unit

Results of a paleontological records search at the UC Berkeley Museum of Paleontology indicated no recorded fossil sites within a five-mile radius of the proposed project site. The closest recorded fossil site, the Lincoln Clay Pit, is approximately 10 miles southeast of the Patterson Sand and Gravel Mine. However, this locality, V67103, includes three specimens obtained from the late Miocene/mid Pliocene-age Mehrten Formation (approximately 4,000,000 to 7,000,000 years Before Present [BP]), which is considerably older than the Riverbank Formation.

Mining activities within the surficial sand and gravel deposits up to 20 feet thick would be located within Holocene (10,000 years BP and younger) alluvial deposits. Since, by definition, an object must be more than 10,000 years old in order to be considered a fossil, operations in these deposits would not have an impact on paleontological resources.

Well-consolidated Pleistocene (11,000–1,800,000 BP) alluvial deposits (i.e. Riverbank Formation) are known to have yielded numerous vertebrate fossil remains in northern California. However, project excavations are planned to occur only in unconsolidated sand and gravel deposits rather than sedimentary rock formations. Furthermore, deposits of the Riverbank Formation were not encountered at the mining site until a depth of 60 feet, and excavation activities are not planned to exceed this depth. Therefore, it is unlikely that impacts to paleontological resources would occur.

SEISMICITY

The project site is located in a seismically active region of northern California. The site and surrounding area are within seismic zone 3 in the Uniform Building Code (UBC), the second highest seismic risk category. (Seismic zones are defined in Section 10.2 below.) The closest active seismic source to the project site is the Foothills Fault System. The Foothills Fault System is a group of northwest-trending, steeply east-dipping to vertical faults formed along the western margin of the Sierra Nevada. The location of these faults in relation to the Patterson mine site is shown in Exhibit 10-3. Faults within the Foothills Fault System include the Cleveland Hills, Swain Ravine, Wolf Creek, and Spenceville faults. The Spenceville Fault is located approximately 3 miles east of the project site. Evaluation of the FFS indicated that seismic activity has occurred on some of these faults within the last 100,000 years. Under the Alquist-Priolo Earthquake Fault Zoning Act (see discussion in Section 10.2 below), a fault is considered “active” if evidence of surface rupture in the last 11,000 years is identified. The only fault within the Foothills Fault System identified as active is a portion of the Cleveland Hills Fault, located approximately 28 miles north of the project site. The 1975 Oroville earthquake occurred on this fault. The Foothills Fault System is considered capable of generating a maximum moment magnitude (M_m) 6.5 earthquake (CDMG 1998).

A second seismic source capable of generating earthquakes that could cause groundshaking at the project site is the Coast Range Sierra Block Boundary Zone. This zone is located along the western margin of the Great Valley and forms the boundary between the Coast Range structural block to the west and the Sierran block to the east. The Coast Range Sierra Block Boundary Zone is a zone of crustal compression manifested by numerous folds and fault segments. Individual fault segments

Exhibit 10-3

along the zone are considered capable of generating M_m 6 or greater earthquakes (Wakabayashi and Smith 1994). The Coast Range Sierra Block Boundary Zone includes the Dunnigan Hills Fault, an active fault located approximately 35 miles southwest of the proposed mine expansion site.

The project site would not be expected to experience fault rupture because no known active or identified faults of any kind traverse the site. However, the area would be subject to moderate groundshaking on nearby and regional faults. Recent evaluations of regional seismic hazards have been conducted to determine probabilistic estimates for seismic shaking levels throughout California. The expected peak horizontal acceleration (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the area, including the proposed project site, is estimated by CDMG to be between 10 and 20 percent of gravity (0.1 to 0.2g) (Petersen et al. 1999).

Secondary risks from seismic groundshaking may include liquefaction, landslide activation, differential compaction, and lurching cracking. If they are saturated, granular unconsolidated sediments such as those found in the northern portion of the site have a relatively high potential for liquefaction when subjected to moderate to strong groundshaking. However, these sediments are generally above the groundwater table and are not saturated. Older alluvial deposits, such as the Riverbank Formation, that underlie the upland area in the southern portion of the site generally have low liquefaction potential because of their level of consolidation. The potential for differential compaction and lurching (a phenomenon associated with liquefaction) would also be low at the project site.

MINERAL RESOURCES

The sand and gravel deposits of the Quaternary alluvium within the valley are recognized as a source of sand and gravel for the production of Portland cement concrete and other aggregate products, as evidenced by the current mining operations at the project site. Aggregate mining has occurred at the project site since approximately 1956.

As required by SMARA, CDMG mapped and classified the available resources within Placer County, including at the project site (Loyd 1995). The majority of the project site is classified as being within Mineral Resource Zone 2a (MRZ-2a)—land where geologic data indicate that significant resources are present (Exhibit 10-4). (For a list of MRZ categories, see "Mineral Resources Classifications" in Section 2.1 of Chapter 2, Project Description.) The remainder of the site and adjacent areas to the south, west, and north along the Bear River channel are classified as MRZ-2b—areas where significant aggregate deposits are inferred on the basis of the available geologic data. Additional exploration, changes in mining and processing technology, or changes in economics could result in reclassification of these areas to MRZ-2a. The areas of the project site classified as MRZ-2a and MRZ-2b areas are also identified as Aggregate Resource Areas (ARAs) that are considered to be immediately available for mining, based on criteria for land use compatibility set by the State Mining and Geology Board. The portions of the property that are currently permitted for aggregate mining (ARA-1) by the applicant are considered to be "Immediately Significant" resource areas and the remaining area (ARA-7) is categorized as "Highly

Exhibit 10-4

Significant." The margins of the Bear River alluvial plain are classified as MRZ-3a, where mineral deposits are known to occur but insufficient geologic data are available to determine the significance of these deposits.

At the time of the CDMG classification study, the estimated resources of Portland cement concrete–grade within ARA-7 was 20 million tons; the resources in ARA-1 were not estimated because of the proprietary nature of permitted areas. The estimated total aggregate resources within Placer County in 1995 was 379 million tons (Loyd 1995). The resources included approximately 50 million tons of aggregate reserves, which are resources that have been permitted by Placer County for mining by three aggregate mining operations. In 1995, CDMG estimated the annual consumption rate of aggregate within Placer County to be 3 million tons/year during the period 1986–1992, while aggregate production within Placer County was estimated to be approximately 2 million tons/year. Therefore, during that period, Placer County was a net importer of aggregate resources to meet the demand (3 million tons/year) for these products for construction projects within Placer County. At that rate of aggregate production and importation, the aggregate reserves within Placer County would be depleted by the year 2020. If importation were to stop and demand was met by aggregate mining within Placer County, the reserves would be depleted by 2008. Increased development within the region since 1995 has resulted in accelerated rates of consumption. The increased demand will be met, in part, by increased production by recently permitted mining operations within Placer County (e.g., Teichert Aggregate).

On the basis of 12 borings at the site, Raney Geotechnical (1998) estimated available volumes of aggregate resources at the project site. Approximately 5 million cubic yards of light-colored, fine sand (i.e., hydraulic tailings) were available in 1998. The estimated volume of available gravel was 10 million cubic yards. Approximately 3.5 million tons of gravel containing weakly cemented rock (i.e., lower quality aggregate) was estimated.

In addition to being classified by CDMG as an area containing known aggregate mineral resources, the area of the site is also classified for the potential presence of placer gold deposits (Loyd 1995). Gold-bearing early Tertiary sediments within Placer County were historically extracted by hydraulic and drift mining techniques. These mining methods, as well as natural erosion, resulted in the transport of gold into the streams and rivers draining the "gold country," including the Bear River. Consequently, gold can be found within the sediments transported and deposited by these streams. The alluvial sediments within the Bear River valley in the area of the project site are classified as MRZ-3a for placer gold resources. The MRZ-3a classification indicates known mineral occurrences of undetermined mineral resources. At the time of the CDMG mineral lands classification study, insufficient information was available to estimate the extent and volume of placer gold resources at and in the vicinity of the site.

SOILS

Soil is generally defined as the unconsolidated mixture of mineral grains and organic material that mantles the land surfaces of the earth. Soils can develop on unconsolidated sediments and weathered bedrock. The characteristics of soil reflect the five major influences on their development: topography, climate, biological activity, parent (source) material, and time. Three general soil types and seven distinct mapping units have been identified at the project site within Placer County by the Soil Conservation Service (USDA Soil Conservation Service 1980). Soils found on the project site are shown in Exhibit 10-5. Topography and the parent material are the strongest influences on the distribution of soil mapping units at the project site. The active channel of the Bear River is mapped as Riverwash. Riverwash soil is highly stratified stony and bouldery sands representing recently deposited alluvial deposits that are frequently or continuously flooded. The asphalt batch plant site and previously mined areas are also mapped as Riverwash. Permeability is very rapid and the erosion hazard is high. These deposits are Capability Class VIII soils with limitations (including excessive drainage and frequent flooding) that nearly preclude their use for commercial crop production.

Portions of the alluvial plain underlain by young alluvium and sediments derived from hydraulic mining are mapped as Xerofluvents. These soils have a sandy texture and moderately rapid to rapid permeability, and are moderately well drained. Surface runoff is slow and the erosion hazard in undisturbed areas is slight. These sandy soils have a low shrink-swell potential. The Xerofluvent soils are subdivided on the basis of the frequency of flooding. Most areas at the project site (including areas protected by levees) are occasionally flooded, but some small topographically depressed areas are classified as being frequently flooded. The capability class of the Xerofluvents at the project site varies (apparently on the basis of available water capacity and frequency of flooding) from Class II (Storie index 69) to Class IV (Storie index 36).

On the south side of the river, at the proposed mine expansion site, portions of the alluvial plain are mapped as Ramona sandy loam. This soil is very deep and well drained with moderately slow permeability; surface runoff is slow and the erosion hazard is slight; and shrink-swell potential is low to moderate. When irrigated, Ramona sandy loam is a Capability Class I soil with few or no limitations for agricultural use. Under nonirrigated conditions, the soil has a Capability Class III rating. The Storie index is 72 for this soil. Current rice production south of the proposed project site is an example of agricultural use of the soil. During Phase 6, the proposed project would result in disturbance of areas mapped as Ramona sandy loam. The slopes of the low hills south of the alluvial plain are mantled Redding and Corning gravelly loams. These soils are moderately deep to very deep and well drained and are developed on older Quaternary alluvium of the Riverbank and Laguna formations. Both soils have a well developed hardpan, which results in a very slow permeability. Runoff rates are slow to medium and the erosion hazard is slight to moderate.

Within the northern portion of the project site located in Yuba County, three distinct soil types have been mapped. Active aggregate mining areas and stockpiles of materials dredged from the river during placer mining operations are mapped as the Dumps. Columbia fine sandy loam is mapped in the area of proposed mining north of the Bear River. This soil is a very deep, somewhat poorly drained soil developed on young alluvial deposits and is the general equivalent of the Xerofluvent soils mapped in Placer County.

Exhibit 10-5

10.2 REGULATORY BACKGROUND

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

The Alquist-Priolo Earthquake Fault Zoning Act (PRC §2621 *et seq.*) was enacted in 1972. The Alquist-Priolo Act prohibits construction of most types of buildings intended for human occupancy across the traces of active faults and strictly regulates construction along active faults. The act is intended to reduce the hazard to life and property from surface fault ruptures during earthquakes; it is not directed toward other earthquake hazards.

Areas along faults considered sufficiently active and well-defined are zoned differently than other areas, and construction in these areas is regulated more stringently. The Alquist-Priolo Act requires the State Geologist to establish regulatory zones known as "earthquake fault zones" around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning efforts. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy.

Before a project can be permitted in the vicinity of an earthquake fault zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet).

SEISMIC HAZARDS MAPPING ACT

The Seismic Hazards Mapping Act of 1990 (PRC §§2690–2699.6) addresses non-surface fault rupture earthquake hazards, including liquefaction, strong groundshaking, and seismically induced landslides. Intended to reduce damage resulting from earthquakes, the Seismic Hazards Mapping Act contains provisions conceptually similar to those of the Alquist-Priolo Act. The state is responsible for identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other earthquake and geologic hazards, and cities and counties must regulate development in mapped seismic hazard zones.

Under the Seismic Hazards Mapping Act, cities and counties may not issue development permits for sites in seismic hazard zones until appropriate site-specific geologic and geotechnical investigations have been completed and measures to reduce potential damage have been incorporated into the development plans. Information on the seismic hazard maps is not sufficient to serve as a substitute for the required site-specific geologic and geotechnical investigations.

CALIFORNIA BUILDING STANDARDS CODE

The State of California provides minimum standards for building design through the California Building Standards Code (CBC) (CCR Title 24). The CBC is based on the federal Uniform Building Code (UBC), which is used widely throughout the United States (generally adopted on a state-by-state or district-by-district basis), and has been modified for conditions within California. The CBC includes a seismic zone map to determine applicable seismic standards for proposed structures. Seismic zones range from 0 to 4, with Zone 0 being the least active and Zone 4 the most active. As mentioned previously, the project site is located in Zone 3.

FEDERAL AND STATE LAWS, ORDINANCES, AND REGULATIONS RELATED TO PALEONTOLOGY

Paleontological resources are classified as non-renewable scientific resources and are protected by several federal and state statutes, most notably by the 1906 Federal Antiquities Act (PL 59-209; 16 United States Code 431 et seq.; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. The proposed project currently does not cross such lands. In addition, protection is provided by other subsequent federal legislation and policies and by the State of California's regulations (i.e., CEQA Section 15064.5 and the California Energy Commission environmental review under the Warren-Alquist Act). Other state requirements for paleontological resource management are found in Public Resources Code Chapter 1.7, Section 5097.5, Archeological, Paleontological, and Historical Sites. This statute specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources. This statute only applies to where the state or a state agency were to obtain ownership of project lands.

There are no state or local agencies having specific jurisdiction over paleontological resources. No state or local agency requires a paleontological collecting permit to allow for the recovery of fossil remains discovered as a result of construction-related earth moving on state or private land in a project site.

PROFESSIONAL PALEONTOLOGICAL STANDARDS

The Society of Vertebrate Paleontology (SVP) (1995, 1996), a national scientific organization of professional vertebrate paleontologists, has established standard guidelines that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, specimen preparation, analysis, and curation. Most practicing professional paleontologists in the nation adhere to the Society of Vertebrate Paleontology assessment, mitigation, and monitoring requirements, as specifically spelled out in its standard guidelines.

10.3 ENVIRONMENTAL IMPACTS

GEOLOGICAL THRESHOLDS OF SIGNIFICANCE

Based on Appendix G of the State CEQA Guidelines, the proposed project would have a significant impact related to geology, minerals, and soils if it would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

- rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area, or based on other substantial evidence of a known fault;

- strong seismic ground shaking;

- seismic-related ground failure, including liquefaction; or

- landslides;

▸ result in substantial soil erosion or the loss of topsoil;

▸ be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in onsite or offsite landslides, lateral spreading, subsidence, liquefaction, or collapse;

▸ be located on expansive soils, as defined in Table 18-1-B of the UBC (1994), creating substantial risks to life or property; or

▸ have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

For the purpose of this EIR, significant geologic hazards would pertain to soil and/or seismic conditions sufficiently adverse that they could not be resolved by standard design, construction, and maintenance practices; in addition, exposing an increased number of people to risk of injury would constitute a significant impact. The potential geologic hazards associated with the proposed project were evaluated based on information contained in the mine reclamation plan prepared for the proposed project (Raney Geotechnical 1998, Carlton Engineering, Inc., 2003). The geologic setting of the proposed project indicates that the possibility of occurrence of other adverse impacts associated with potential geologic hazards not listed above is negligible.

PALEONTOLOGICAL THRESHOLDS OF SIGNIFICANCE

Based on Appendix G of the State CEQA Guidelines, the proposed project would have a significant impact related to paleontological resources if it would:

▸ directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined. Areas where fossils have been previously found are considered to have a high sensitivity and a high potential to produce fossils. In areas of high sensitivity that are likely to yield unique paleontological resources, full-time monitoring is typically recommended during any project ground disturbance. Areas that are not sedimentary in origin and that have not been known to produce fossils in the past typically are considered to have low sensitivity and monitoring is usually not needed during project construction. Areas that have not had any previous paleontological resource surveys or fossil finds are considered undetermined until surveys and mapping are performed to determine their sensitivity. After reconnaissance surveys, observation of exposed cuts, and possibly sub-surface testing, a qualified paleontologist can determine whether the area should be categorized as having a high or low sensitivity. In keeping with the significance criteria of the SVP (1995), all vertebrate fossils are generally categorized as being of potential significant scientific value.

The significance of potential adverse impacts to paleontological resources under CEQA, resulting from project-related activities at the Patterson Sand and Gravel Mine site, was determined using the SVP (1995) criteria.

PROJECT IMPACTS

Impact
10-1

Erosion of Reclaimed Slopes. *The proposed reclamation activities would result in the construction of fill slopes with a mantle of processing fines that could be highly erosive. These fill slopes could experience substantial erosion and therefore could affect water quality. This impact is considered* ***potentially significant.***

The proposed reclamation activities would result in the construction of fill slopes no steeper than 2.25:1. The completed fill slopes would be mantled with approximately 6 inches of processing fines, which would serve as the growth medium for revegetation of the slopes. The processing fines are described in the application as silty, fine sand. When exposed (i.e., not sufficiently vegetated), these sediments are highly erosive. If significantly eroded, successful reclamation of the slopes could be compromised. In addition, erosion of the slopes could result in adverse sediment transport to water bodies (including the Bear River and the proposed reclaimed lake) with potentially adverse impacts on water quality and aquatic habitat. The mine reclamation plan includes slope vegetation and other best management practices (BMPs) proposed by the applicant as mitigation that would reduce and control the erosion risk. However, this impact is considered potentially significant.

Impact
10-2

Unstable Fill Materials. *Placement of fill at the project site could result in areas of unstable geotechnical conditions, such as liquefaction and landslides. New structures, such as the asphalt batch plant, constructed at locations with unstable conditions could be affected by liquefaction. Therefore, this impact is considered* ***potentially significant****.*

The mine reclamation plan includes construction of several types of earthen fills. The fills include construction of fill slopes no steeper than 2.25:1 at the margins of the mining pits, filling of settling basins with processing fines, placement of processing fines for orchard development, and levee construction. The mine reclamation plan presents specifications for slope design and soil compaction testing for construction of fill slopes and the levee. All slopes would be constructed in accordance with the requirements of the UBC; therefore, the risk for landslides would be minimal. These specifications are generally appropriate for the proposed end uses (i.e., agriculture and open space) of these features and consistent with the requirements of SMARA. However, the proposed fill designs may not be appropriate for supporting building foundations. During moderate to strong groundshaking, saturated sediments can undergo a type of failure referred to as liquefaction. During liquefaction, elevated pore water pressures cause a complete and sudden loss of strength and the sediments are transformed from a solid state to a liquid state. In a liquid state, the sediments have no bearing capacity and can flow. The results of flow can include collapse or settlement of the ground surface. Significant damage or collapse of structures built in areas affected by liquefaction could occur.

The sediments deposited in the filled settling basins may be subject to settlement and liquefaction, if saturated, during moderate groundshaking. These conditions could result in damage to structures built in these areas. The proposed asphalt batch plant would be constructed within a filled settling basin. The mine reclamation plan (Section 3.7.2) acknowledges that additional site-specific geotechnical engineering for structure foundation would be necessary before the design and construction of the asphalt batch plant. With construction of the asphalt batch plant or other structures on potentially unstable fill material, this impact is considered potentially significant.

Impact
10-3

Potential Pit Capture From Separator/Levee Erosion and Instability. *Lateral migration of the Bear River channel could result in destabilization of the riverward side of the proposed levee extension at the Patterson mine site. Erosion or slope failure along the levee could result in "pit capture" of the proposed mine pit and reclaimed areas. Therefore, this impact is considered* ***potentially significant****.*

The proposed project would result in excavation of mining pits to depths as much as 60 feet below the deepest part of the channel of the Bear River. The pits would be separated from the river by unexcavated alluvial sediments (a "separator") on which a levee is being constructed as part of the currently permitted operation. The separator and levee would consist of erodible, unconsolidated sediments. Flow velocities within the river would be capable of eroding the riverward margin of the separator and levee. Erosion of the toe of the separator/levee slope could result in oversteepening of the slope and slope failure. An example of the potential for bank erosion is present along the north bank of the river, approximately 2,000 feet downstream (west) of the existing bridge across the river at the project site. This area of bank erosion affects approximately 500 linear feet of the bank at the outside of a meander bend. The bank is oversteepened and exposed soil indicates relatively recent shallow rotational failures. Progressive bank failure is likely unless erosion of the toe of the slope is mitigated. Future downstream migration of the meander can be expected.

The proposed westward extension of the existing levee through this area could be adversely affected by this type of bank erosion. Erosion of the proposed separator/levee extension and related progressive slope failure could eventually result in breaching of the land separating the mining and reclamation areas from the river. Breaching of the extended separator could cause the flow in the river to be directed into the lowered land surface in the proposed mining/reclamation area, forming a permanent hydraulic connection between the river and the pit. Inundation of this area could significantly damage proposed reclamation features. Fish from the river may be entrapped and subject to predation. In addition, sediment transported by the river may be directed into the pit and deposited. The resulting decrease in sediment load and formation of a knickpoint (a point of abrupt change in the stream profile [i.e., slope]) in the channel may cause streambed degradation. Upstream migration of the knickpoint and associated degradation would be expected, potentially destabilizing the onsite bridge over the channel and, in time, possibly adversely affecting the diversion dam located approximately 3,000 feet upstream of the project site. Because erosion of the proposed separator/levee extension could result in a permanent hydraulic connection between the river and proposed mining pit area that could adversely affect proposed reclamation features, this impact is considered potentially significant.

Impact
10-4

Potential Cut Slope Instability Adjacent to Existing Irrigation Canal. *Cut slopes created during mining could be potentially unstable. Cut slope failure along the northern margin of the project site could damage the existing irrigation canal. This impact is considered **potentially significant**.*

The mine reclamation plan describes the maximum steepness of final reclaimed slope as 2:1 in the north margin of the project site (Carlton Engineering, Inc., 2003). The steepness of the cut slopes formed during the mining period would be 2:1 for slopes excavated in the upper 35 feet of the subsurface and 1.75:1 for slopes below 35 feet. The estimated factor of safety for the proposed mining slopes is 1.5 or greater (Carlton Engineering, Inc., 2003). (Factor of safety is the ratio of the combined forces that resist slope failure [e.g., strength, cohesion] to the combined forces that drive slope failure [e.g., stress, pore pressure]. Stated differently, factor of safety is the ratio of shear strength to the shear stress required for slope equilibrium [i.e., stability].) The estimated factor of safety is greater than the suggested minimum factor of safety (1.25) recommended by Caltrans for cut slopes where failure would not be catastrophic with respect to impedance of traffic or dangerous to human life or contiguous structures. The failure probability for slopes designed by engineers for a factor of safety of 1.5 and built with adequate supervision has been estimated to be 0.0001 (0.01 percent) (Wu et al. 1996).

The most critical slopes proposed by the project would be at the northern edge of the site adjacent to the Camp Far West Canal. The project proposes to continue mining within 50 linear feet of the existing concrete-lined irrigation canal. If slope instability along the mining excavation in this area were to result in ground movements, the project could cause damage (e.g., linear cracking) to the canal. This impact is considered potentially significant.

Impact
10-5

Potential Paleontological Resources. *No known paleontological resources occur within the top 60 feet of unconsolidated sand and gravel deposits at the proposed mine expansion area. However, excavation into consolidated Pleistocene sediments at any depth could result in the disturbance of paleontological resources. This impact is considered **potentially significant**.*

Based on the records search, literature search, and stratigraphic inventory described above, no evidence of unique paleontologic resources was found within the top 60 feet of unconsolidated sediments at the proposed mine expansion area. Although project mining activities would be expected to be confined to these unconsolidated sand and gravel deposits, any excavation into Pleistocene-age consolidated sediments could yield unique paleontologic resources. Therefore, this impact is considered potentially significant.

10.4 MITIGATION MEASURES

Mitigation measures are provided below for *significant* or *potentially significant* impacts of the proposed project.

Mitigation Measure P10-1: Implement Best Management Practices for Soil Erosion Control. The applicant shall implement the following appropriate BMPs identified in the mine reclamation plan for soil erosion control during construction of fill slopes:

- Vegetation removal shall not precede mining by more than 12 months.
- All fill slopes shall be designed and constructed in accordance with the requirements of the UBC to minimize the potential for slope instability and erosion and shall not exceed a steepness of 2.25:1.
- Vegetative cover material (soil) shall be placed (at a thickness of 6 inches) on reclaimed valley floor and mine slopes and revegetated as it is placed. Seeds for vegetative cover shall be broadcast with a mechanical spreader in the early fall, and covered with soil immediately following broadcasting.
- Final graded fill slopes shall be tracked with machinery to provide grooves to minimize sheetflow velocity and catch seeds transported in runoff.
- Straw mulch shall be spread over revegetation areas before and after seeding/planting. The mulch shall be spread or blown to create a cover depth of 2–3 inches at a rate of 2 tons/acre. Straw mulch shall be anchored by punching the mulch into the growth media with a roller punch or crimper punch.
- Silt fencing shall be installed near the toe of any fill slopes with exposed (unvegetated) soil.
- Contour furrows (shallow ditches) shall be constructed or straw wattles (rice straw wrapped in tubular plastic netting) shall be placed along contour on final graded fill slopes at a minimum spacing of 50 feet (slope distance) on levee slopes to minimize runoff velocity and catch seeds transported in runoff.
- Reclamation plants will be watered (irrigated) if necessary using a water truck to promote plant growth before the onset of seasonal rains.
- Pursuant to §2773 of SMARA, the reclamation revegetation shall be monitored for 3 years to ensure success in establishment of adequate cover for erosion control. The performance standard for seeded areas shall be 80 percent vegetative cover with no bare areas larger than 10 feet by 10 feet.

Mitigation Measure R10-1: Direct Runoff from the Top of Excavated Slopes. The applicant shall perform grading in a manner that directs runoff away from the top of excavated slopes and into controlled drainage conveyance structures.

Mitigation Measure P10-2: Prepare a Geotechnical Engineering Report for Foundations. If new structures, including the asphalt batch plant, are proposed in backfilled areas of the site, the applicant shall prepare a geotechnical engineering report to resolve potentially unstable soil conditions for foundations in areas of fill. The geotechnical investigation shall include subsurface testing of soil and groundwater conditions at the location of proposed structures and determine appropriate foundation designs that are consistent with the California UBC. Final design of the proposed asphalt batch plant shall incorporate the results of the geotechnical engineering report.

Mitigation Measure R10-2: Identify Unstable Fill Materials. Before final site reclamation associated with the proposed mine expansion project, the applicant shall identify all filled sediment basins or other areas of uncontrolled fill at the site on a scaled map, and shall include this information in the deed restriction for the project site to allow recognition of these areas as potentially unstable for future construction of new structures.

Mitigation Measure R10-3: Implement Erosion Control Measures. The applicant shall implement the following mitigation measures to ensure the preservation of the land separating the active channel of the Bear River from the lowered mining and reclaimed mining areas north of the river:

- The offsite portion of this mitigation measure only applies if the owners of offsite lands provide permission to enter their lands after the project applicant has made good-faith efforts to obtain such permission. During the mining and reclamation period, a licensed engineer or certified engineering geologist shall annually inspect the banks of the Bear River within the project site boundaries to determine whether significant bank erosion or potential for bank erosion has developed. Significant bank erosion shall be indicated by erosion and oversteepening of the riverward toe of the levee slope or more than four feet of lateral erosion of the stream bank. Identification of significant erosion at the project site shall require the development of a remedial action plan. The plan shall, to the extent feasible, incorporate biotechnical bank protection technologies. The plan shall be submitted to Placer County for review and approval before excavation of the area southwest of the existing mining operation. A report of the bank inspection (including any recommendations for remedial actions) shall be submitted to Placer County by July 1 of each year. Following Placer County approval, recommended remedial actions shall be implemented within 1 year of obtaining all necessary permits or approvals required for the remedial action.

- Following completion of reclamation, Placer County will inspect the separator between the mining area and the Bear River once every 5 years, and after any major flow event exceeding a 5-year flow, to determine whether significant bank erosion threatens or has the potential to threaten the integrity of the separator. If Placer

County determines that damage requires repair to meet the intended performance of the separator, the applicant shall perform the required repair.

Mitigation Measure P10-4: Minimize Potential for Damage to the Existing Irrigation Canal. The applicant shall implement the following mitigation measures to minimize the potential for damage to the existing irrigation canal related to failure of mining cut slopes:

- Excavation of mining slopes shall not occur less than 50 feet from the existing irrigation canal located at the northern margin of the project site.

- Mining slopes shall not exceed a steepness of 2:1 above a depth of 35 feet and 1.75:1 below 35 feet. These slopes are expected to have a factor of safety of 1.5 or greater (Carlton Engineering, Inc., 2003).

- The mining pits adjacent to the irrigation canal shall be backfilled to approximate existing grade, forming a 500-foot-wide buttress fill adjacent to the canal.

Mitigation Measure R10-5: Minimize Potential for Damage to Unknown Paleontological Resources. The applicant shall implement the following mitigation measure to minimize the potential for damage to paleontological resources:

- In the event that paleontological resources are discovered during land alteration activities, the mining crew shall immediately cease work in the vicinity of the find. A qualified paleontologist approved by Placer County shall be consulted to evaluate the resource, and a mitigation plan shall be prepared in accordance with local and Society of Vertebrate Paleontology guidelines.

10.5 LEVEL OF SIGNIFICANCE AFTER MITIGATION

Following implementation of the above mitigation measures, all potential impacts related to geology, minerals, soils, and paleontology would be reduced to a *less-than-significant* level.